Five samples of ash from Roche Percee, near the Souris River, were gathered the same year.

The time of felling of all the trees, except one at Trossachs and one at Roche Percee, was known. It was found by cross identification, however, that two of the trees whose date of felling was known had been dead for a year or two before being cut. The two trees whose dates of felling were not known were easily cross identified with the others, wide rings being found as valuable as narrow ones for this purpose.

Width of the rings was measured with an ordinary wooden ruler in centimeters by eye. The longest radius was used in each case for ease in measurement. The record from each tree was plotted separately on cross-section paper and cross identified with others in the group. The later years in some of the old trees showed small annual variations and were omitted, as they would have tended to smooth the curve. The average growth for each tree was then calculated. The percentage which each year's growth was of the average was then determined. These figures were averaged, making two graphs showing annual percentage variation of radial tree growth from the average, at Roche Percee and Torssachs.

A relationship between the two curves was found to to exist. One white spruce from Maple Creek was also found to have a relationship to the Trossachs curve. The Trossachs chart was then correlated with wheat yields per acre in crop district No. 2 (Regina-Weyburn) the coefficient being $+0.31 \pm 0.10$. Since the surrounding crop districts show relationship with crop district No. 2, this Trossachs curve shows to some extent crop conditions in southern Saskatchewan. Large discrepancies occurred in years when rust affected wheat, as in 1916, or where frost killed buds in trees, as in 1915, which was a bumper crop year, but a poor year for the trees. The Roche Percee curve showed no relationship to wheat yields in crop district No. 1, where Roche Percee is situated; however, Dr. O. C. Stine, of the United States Department of Agriculture, found that this curve shows a relationship to crop yields in North Dakota.

It was thought that since trees are perennial and wheat is an annual plant, there might be a lag in tree growth due to conservation of energy in the tree and soil moisture which the roots could reach. To determine the amount of this lag the Trossachs curve was correlated with the same series of figures for the previous year. r was $+0.58 \pm 0.03$. So the relationship is r or practically one-third. The chart was corrected by subtracting from each figure one-third of that of the year previous, and the revised curve correlated with wheat yields. The improved correlation, $r = +0.38 \pm 0.01$, justified the correction.

The charts were examined by several parties for cycles, but no small cycles were found to predominate. However, Dr. Dayton C. Miller, of Cleveland, Ohio, found evidence of a cycle of over 50 years, suggesting the 55-year weather cycle discovered by other investigators.

The conclusions from this study are as follows:

1. There had been enough moisture in southern Saskatchewan to grow trees for the last 150 years.
2. Extremely poor years have been the exception.
3. A relationship exists between tree growth at Trossachs and wheat yields per acre in southern Saskatchewan, improved by eliminating moist years which cause rust and cold years which are bad for tree growth.
4. A correlation exists between Roche Percee tree growth and wheat yields in North Dakota.
5. There is a relationship between tree growth at Roche Percee and Trossachs.
6. Roche Percee tree growth is not related to wheat yields in southern Saskatchewan; Trossachs tree growth is not related to wheat yields in North Dakota.
7. There is a carry-over of one-third of each year's tree growth to the next year due to the conservation of energy in the tree, or soil moisture, or both.
8. The only important cycle found was one of over 50 years.
9. Trossachs tree growth correlated with Qu'Appelle May–June rainfall (1884 to 1931) gave $r = +0.32 \pm 0.09$.
10. Lack of short cycles makes prediction of wheat yields from tree growth impossible.

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A REVIEW OF "THE STRUCTURE OF THE WIND OVER LEVEL COUNTRY"

[Meteorological Office Geophysical Memoirs No. 54, by the late M. A. Giblett and other members of the staff. Pp. 119, with 21 plates]

By G. GRIMMINGER

[Weather Bureau, Washington, D. C.]

This important memoir is divided into five distinct parts.

Part 1. Instrumentation and installation.—Dines pressure tube anemometers were mounted at the tops of four 50-foot towers, three of which were set at the corners of an equilateral triangle having sides of 700 feet, approximately the length of a rigid airship. About 3,500 feet away from this triangle there was a fifth tower 150 feet high at the top of which were mounted an anemometer and a recording electrical thermometer, thus making it possible to determine the vertical gradient of wind speed and of temperature at any time. The wind directions were recorded on Baxendall recorders. In order that the details of the fluctuations in speed and direction might be studied, open-time scales were used, the largest giving 1 inch of record in 42 seconds. An analysis is given of the instrumental errors in the speed and direction records.

Part 2. Horizontal fluctuations in wind in time and space.—The results of a statistical study of the records are discussed and some of the conclusions reached are as follows: During an adiabatic or superadiabatic gradient large, or major, eddies are present which vary in length (down wind) from 3,000 to 8,000 feet and in width (across wind) from 600 to 2,000 feet. These major eddies are characterized on the speed record by fluctuations of comparatively long period, each of which shows a sharp increase in speed followed by a gradual decrease. Imbedded in the major eddies are a large number of smaller eddies which are recognized on the speed record by numerous short period fluctuations superimposed on the fluctuations of long period. On the other hand, when a surface inversion is present there are no pronounced major eddies, the gusts being due mainly to the small scale eddies, which may also disappear if the inversion becomes strong enough. Some interesting records are included which show the sudden changes occurring in wind speed and direction during the passage of fronts and thunderstorms.

Part 3. A theory of eddies.—In this part C. S. Durst puts forward a theory to explain the two main types of eddies mentioned in part 2. The short period eddies are thought to be due to the reaction between the air stream and surface obstacles and to the friction between the air and the ground. The major eddies, however, are believed to be thermal in their origin and due to convection currents set up in the atmosphere, since they occur only when the lapse rate is favorable for convection. From laboratory experiments on convection in liquids Durst concludes that when the convectional eddies are present the lower portion of the atmosphere takes on a cellular structure, and that each cell contains a convectional eddy which is identical with the major eddy mentioned above. The cells travel with the mean velocity of the wind, while the motion of the air within a cell relative to the mean wind is supposed to be as follows: Relatively cool air moving with the velocity of the upper layers descends in the forward part of the cell; upon contact with the ground, its forward motion is checked and it moves toward the rear of the cell becoming heated and filled with frictional eddies. This air is relatively warm when it nears the rear of the cell and therefore rises to the cell top where it moves forward toward the front of the cell; it then descends again, and the cycle is repeated. The horizontal dimensions of the cells would be the same as those given for the major eddies in part 2, and their heights 1,500 feet or more. This novel theory postulating the existence of atmospheric cells, each containing a convectional eddy, explains a number of the facts revealed by the anemograms, and merits further investigation.

Part 4. The variation of wind with height.—As a result of a study of the records made by instruments at the heights of 30, 40, 50, and 150 feet, it is found that the vertical gradient of wind speed is usually less for light winds than for strong and less by day than by night; and also that the vertical gradient of wind speed depends on the vertical temperature gradient.

Part 5. Application of the results of the investigation to the hydrodynamical theory of turbulence.—Data are given here showing that a strong surface inversion has the effect of reducing the coefficient of turbulence. From the consideration of the equations of motion of a turbulent fluid, it is concluded that when the convectional eddies are present, the simplified form of these equations, in which the coefficient of viscosity is replaced by the coefficient of eddy viscosity, is rigorously applicable only for heights above 1,500 feet.

This investigation appears to be the first of its kind in which simultaneous records have been made not only of wind speed but also of wind direction and of temperature. The concept of the convectional eddy and its theory are entirely new. The memoir represents a searching investigation into wind structure and merits the attention of all who are interested in this branch of meteorology.

It may not be out of place to mention here that a research on wind gustiness was begun several years ago at the University of Michigan by R. H. Sherlock and M. B. Stout and is still in progress. It is anticipated that the final results of this investigation will contribute further to our knowledge of wind structure.

THE TROPICAL STORM OF OCTOBER 30–NOVEMBER 13, 1932

By C. L. MITCHELL

[Weather Bureau, Washington, Dec., 1932]

This storm was remarkable not only for its great intensity so late in the hurricane season, but also because of its unusual path during its early history and its moving into the Caribbean Sea at least two weeks later than any other tropical disturbance of hurricane intensity during the last 50 or more years.

The first evidence of this cyclonic circulation was noted on October 30 about 200 miles east of the island of Guadeloupe, West Indies. The disturbance, which was yet of slight intensity, passed over or near Guadeloupe during the 31st. During the next two days its direction of movement was unexpected, and, for this low latitude, unprecedented. Instead of passing westward a short distance south of Puerto Rico, it moved almost directly southwestward, apparently reaching hurricane intensity on November 2, and it was central approximately 75 miles north of Willemstad, Curacao, Dutch West Indies, the morning of that date. The next day its center passed westward about 50 miles north of Punta Gallinas, Colombia, the northernmost point of South America. For three days—November 2 to November 5, inclusive—the disturbance moved very slowly westward with steadily increasing intensity, the steamship *San Simeon* in lat. 14° 30′ N., long. 79° W., reporting a barometer reading of 28.48 inches and a southeast wind of force 12 at 7 a. m. of the 6th, just as the disturbance started to recurve to the north. During the night of the 8th–9th the storm recurved to the northeast and began to move more rapidly, the center passing near Cayman Brac on the early morning of the 9th. Later in the forenoon it passed inland over Cuba near Santa Cruz del Sur and between 1 p. m. and 2 p. m. it passed to sea again near Nuevitas, where a barometer reading of 28.85 inches and an estimated wind velocity of 125 miles per hour were reported. Charts VIII, IX, and X illustrate this storm on the 7th, 9th, and 11th, and show its track up to the latter date.

During the next several days the storm moved almost directly northeastward, and finally merged on the 13th with an extensive disturbance that passed eastward over the Canadian maritime Provinces and Newfoundland during the 12th–13th. At 8 a. m. of the 12th, St. Georges, Bermuda, reported a pressure of 29.38 inches, but it undoubtedly was lower later in the forenoon, when a maximum wind velocity of 88 miles per hour from the north was registered at that place.

The reports of damage caused by this very severe tropical storm are quite incomplete. Press dispatches indicate that some damage resulted along the northern coasts of Venezuela and Colombia and on Providence Island and Cayman Brac in the western Caribbean Sea. On Providence Island 36 houses were reported destroyed and crops ruined, while on Cayman Brac 69 persons were reported killed, hundreds were injured, and the island almost completely devastated.

The storm damage at Santa Cruz del Sur, Cuba, reached the proportions of a major catastrophe. According to the Associated Press the number of deaths reached 2,500 and less than 10 per cent of the town's 4,000 inhabitants escaped unhurt. The survivors stated that the hurricane began about 3 a. m. of the 9th, later driving the sea into the town and "converting it into a great lake," with scarcely a house left standing. Damages are estimated tentatively at several millions of dollars.

The damage on the island of Jamaica was comparatively small, except that there was over a 50 per cent loss to banana trees in some localities.

Advisory warnings were issued twice daily for a period of two weeks, beginning on October 31.